Corrupted MP4 Carving using MP4-karver

AHMED NUR ELMI ABDI

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DEDICATION

All praise and thanks are due to Almighty Allah, Most Gracious; Most Merciful, for the immense mercy which have resulted in accomplishing this research. Thank you Allah giving me health.

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ABSTRACT

The usage of digital video is rapidly increasing recently. The analog CCTV systems are replaced by digital systems. Moreover, digital cameras and smartphones are increasingly popular and becoming affordable. The criminals use these digital devices; particularly smartphones to record crimes such as child pornography and other violent activities. Many at times, these videos are altered or deleted by the criminals in order to avoid persecution by the law enforcement. In digital forensic, carvings of deleted, damaged video files have an important role in searching for evidence. Therefore, many existing tools and techniques such as Scalpel's, PhotoRec, Bi-Fragment Gap Carving (BGC), Smart Carving and Frame Based Carving attempt to carve the videos files, but some of the carved videos files are usually corrupted or damaged and not playable. However, there is still room for improvement in repair corrupted MP4 videos to make it playable. In this research, MP4-Karver tool is proposed to carve and repair the corrupted MP4 videos. MP4-Karver is developed by using visual studio platform in C# programming language. The proposed MP4-Karver tool focuses on carving, repair corrupted MP4 videos and getting a higher successful rate of playable MP4 video file format. The experimental result shows that the proposed MP4-Karver tool increases the restoration carving and repairing of MP4 corrupted videos with average of 97% improvement as compared to PhotoRec and Scalpel. The MP4-Karver tool is a good alternative for MP4 videos restoration and repairing damaged videos as compared to other tools and techniques.

ABSTRAK

Penggunaan video digital semakin meningkat hari demi hari secara pesatnya sejak kebelakangan ini. Kebanyakan sistem analog CCTV telah digantikan oleh sistem digital. Tambahan pula, kamera digital dan telefon pintar semakin popular dan harganya telah menjadi mampu milik. Penjenayah-penjenayah juga telah menggunakan peranti-peranti digital ini terutamanya telefon pintar dalam merekod jenayah mereka seperti pornografi kanak-kanak dan aktiviti-aktiviti keganasan yang lain. Walaupun begitu, kebanyakan video-video ini telah diubah atau dipadam oleh penjenayah demi mengelakkan diri dari hukuman pihak berkuasa. Di dalam forensik digital, mengukir fail video yang dipadam dan rosak memainkan peranan yang penting dalam penyiasatan bukti-bukti. Oleh itu, banyak pendekatan sedia ada seperti Scalpel , Bi-Fragment Gap Carving, Smart Carving dan Frame Based Carving telah digunakan dalam usaha untuk mengukir video-video dengan kaedah-kaedah yang berbeza, namun video-video yang telah diukir kebiasaannya tidak dapat dimainkan. Walaupun begitu, alat-alat dan teknik-teknik pegukir fail ini tidak berupaya untuk membaiki video MP4 yang telah rosak dan menjadikan video tersebut supaya boleh dimainkan semula. Di dalam kajian ini, alat MP4-Karver telah dicadangkan untuk mengukir dan membaiki video yang telah rosak. Alat ini dibangunkan di dalam bahasa pengatucaraan C#. MP4-Karver yang dicadangkan,mangutamakan fungsi ukiran dan membaik pulih video yang telah rosak kepada video yang boleh dimainkan semula. Keputusan eksperimen menunjukkan MP-4 Karver ini berupaya meningkatkan tahap nisbah pemulihan MP4 dan membaik pulih video yang rosak dengan kadar 97% lebih baik berbanding dengan alat-alat yang lain seperti PhotoRec dan Scalpel. Kesimpulannya, alat MP4-Karver ini mampu menjadi alat alternatif dalam membaik pulih video MP4 yang telah rosak berbanding alat-alat yang lain.

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LIST OF ALGORITHMS

LIST OF SYMBOLS AND ABBREVIATIONS

PDF	-	Portable Document Format
AVI	-	Audio Video Interleaved
WAV	-	Waveform Audio File Format
MP3	-	MPEG Audio Layer 3
MOV	-	QuickTime Movie (file extension)
3D	-	Three-Dimensional film
AVC	-	Advanced Video Coding
FTYP	-	File type box
MOOV	-	Movie box
MDAT	-	Media Data Box
GIF	-	Graphics Interchange Format
JPG	-	Joint Photographic Experts Group
PNG	-	Portable Network Graphics
SWF	-	Small Web Format
FLV	-	Flash Video
DFRWS	-	Digital Forensics Research Workshop
CCTV	-	Closed-Circuit Television
MP4	-	MPEG-4
FAT16	-	File Allocation Table 16
NTFS	-	New Technology File System
P2P	-	Peer-to-peer
STSZ box	-	Sample Size Box
NFI	-	Nederlands Forensisch Instituut
ASF	-	Advanced Systems Format
3GP	-	Third Generation Partnership

MMC	-	Microsoft Management Console
USB	-	Universal Serial Bus
eDiscovery	-	Electronic discovery
CD-ROMs	-	Compact disc used as a read-only optical memory
APIs	-	Application program interface
MD5	-	Message Digest 5 Algorithm
SHA1	-	Secure Hash Algorithm 1
IRS-CI	-	Internal Revenue Service Criminal Investigation
PC	-	Personal Computer
AVC	-	Advanced Video Coding
2D	-	2-Dimensional
DVD	-	Digital Video Disc
ASMD	-	Automatic Standard MP4 Duplicator

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LIST OF PUBLICATION

Journal:

(i) Ahmed Nur Elmi Abdi, Kamaruddin Malik Mohamad, Yusoof Mohammed Hasheem, Rashid Naseem, Jamaluddin and Muhammad Aamir, “Corrupted MP4 Carving Using MP4-Karver” International Journal of Advanced Computer Science and Applications (IJACSA), 7(3), 2016.

CHAPTER 1

INTRODUCTION

1.1 An Overview

The application of smart devices, such as smartphones and CCTV recording videos has increased tremendously, especially in the last decade [1]. One of the remarkable technological breakthroughs of the 21st century is the invention of devices, such as the smartphones, digital cameras, CCTVs and security cameras, which are used to capture images and record videos of events. The demand for these devices from individuals and business corporations keep increasing which results from more productions and in turn, makes their prices much lower [2].

Besides, these devices are also used to record illegitimate and criminal activities, such as murder, robbery, and rape. The information retrieved from these devices can be used to identify criminals involved in a particular crime and being brought to justice. In criminal investigations, recorded video data on storage media often provides important evidence for a case. To ease the effort to search for recorded video data about crime, video data restoration and video file carving has been actively studied [3]. Carving of corrupted or damaged video files has an important role in digital forensics for finding every bit of video data and making it viewable which can be crucial to the investigation.

Conventional file restoration techniques find meta-information of the deleted files to search for physical locations containing actual file contents [4]. However, the file cannot be restored if the file links are lost.

Since a video file typically has a large volume, it is very likely to be fragmented or corrupted although the meta-information remains in the file header. The existing techniques were signature based file restoration technique such as Bi-fragment gap carving (BGC) technique, Smart carving technique, and Frame-based recovery. These techniques introduced the method of providing a signature to the file system, i.e. providing header and footer to the file system. However, this technique is not efficient when a target video file was severely fragmented, corrupted or even has a portion of video overwritten by other video contents. The ability of existing techniques to retrieve the videos is less than 50% [5].

In this study, an improved MP4 carving tool has been proposed, in which corrupted and non-corrupted carves MP4 files from mobile phones or CCTVs could be made playable again. The proposed tool has been developed using the C# programming language.

1.2 Problem Statement

The use of digital video has been rapidly increasing. Analogue CCTV systems have been replaced by their digital counterparts. According to Pew Research, criminals use digital devices, such as digital cameras and smart phones to record crimes, such as child pornography and other violent activity. Many times, these videos were altered or deleted by the criminals in order to avoid prosecution by the law. In digital forensics, it is important to retrieve and carve damaged or deleted videos. Finding every bit of video data and making it reviewable can be crucial to the investigation. Many existing approaches have attempted to carve a video file using the header of the video. In some cases, a target video file is severely fragmented, corrupted or even has a portion of video overwritten by other video contents. However, existing video file carving approaches fail to carve non-playable or incomplete MP4 videos. For instance, PhotoRec and Scalpel tools are not able to carve non-viewable, incomplete files from corrupted, fragmented video files. This research proposes an automatic repairing technique for carving corrupted MP4 video files that are complete and playable.

1.3 Aim and objectives of study

The aim of this study is to propose an improved tool for carving and repairing MP4 video files. To help digital forensic investigators to search evidence from carving corrupted MP4 videos and make it playable.

The objectives of this research are:

(i) To propose automatic repairing technique for carving corrupted MP4 video files.

(ii) To develop and implementing the proposed tool(i);

(iii) To test the accuracy of successful number of playableMP4 videos carved using DFRWS 2007 and Level_3 datasets and compare it with PhotoRec and Scalpel carver tools.

1.4 Scope of study

This research focuses on carving to acquire higher successful carving rate on playable MP4 video files. The proposed tool only evaluates the accuracy of the carving number of playable MP4 videos. This research particularly deals with carving corrupted, damaged, incomplete MP4 videos into re-playable videos, even for MP4 video that was produced from CCTV or any other devices built with cameras.

1.5 Outline of the thesis

The rest of the chapters in this thesis are organized as follows: Chapter 2 gives an introduction of file carving, the existing file carving tools and techniques, comparison of existing tools, magic numbers, MP4 overviews and performance measurement. Chapter 3 discusses research framework. Chapter 4 discusses algorithm development, MP4-Karver components and software/hardware requirements. Chapter 5 elaborates the experiments and results obtained from MP4-Karver, PhotoRec, and Scalpel. Finally, Chapter 6 concludes the research and gives suggestions for future work.

CHAPTER 2

LITERATUREREVIEW

2.1 Introduction

Carving of damaged or corrupted video files obtained from a crime scene may provide key evidence to resolve the case. Conventional techniques for video file restoration makes use of meta-information the file system to retrieve a video file stored in a storage medium, such as a hard drive or a memory card [6]. The file system's meta-information contains some system data, such as the address and the link to a video file that can be used for file restoration. Carrier proposed a file restoration tool based on a file system, which was implemented in software toolkit [7]. Sleuth Kit is based on information from the file and directory structure of a storage file system. Video file restoration may not be possible with such technique when the file system's meta-information is not available [8].

Thus, attempts have been made to restore the video data from video contents, rather than the meta-information of a file system. This research also introduces a technique to restore damaged or corrupted video files irrespective of a file system. A signature-based video restoration technique proposed to address this problem [9]. The method creates a database of the file header (i.e. the beginning mark of a file) and footer (i.e. the end mark of a file) and defines a set of rules for a specific file type. This signature-based file recovery technique does not require file system information, which can be applied to a video file without meta-information because of file system change and reformatting of a storage medium. The signature-based file recovery techniques identify fragments from byte sequence (or magic bytes) containing file header or footer.

The scalpel does not rely on a file system to restore a video file [10]. This technique requires an indexing step to find the file header and footer from whole disk as well as a restoration step to recover the indexed header and footer. It does not use file system's metadata to restore data between header and footer to a file.

However, this method has limitations when the files are un-fragmented. It does not recover partially overwritten video files. Garfinkel utilized additional information stored in a file to extend the idea to signature-based restoration techniques. For some files, the header may contain the information of file size or length. When the file footer does not exist, they can use this information to extract a file [11]. A video file can be restored using Bi-fragment gap carving (BGC) [12]. This method finds a combination of the region containing the header and the footer to test if a video sample is valid. It computes the difference between two data regions and checks if the difference passes a predefined validation procedure. This procedure repeats until the gap passes the validation test. However, this method can only be applied to a video file with two fragments and it does have limitations when the gap between the two file fragments is large.

Smart carving technique was proposed to restore a file without being restricted by the number of fragments [13]. This technique identifies occurrence of fragmentation combines permutations of fragment components and searches for the order of fragments. The technique consists of three steps, namely preprocessing, collation, and reassembly. The preprocessing step collects called block part, which was not allocated to a file using the file system information to reduce the size of data to be analyzed. The collation step categorizes collected blocks in the preprocessing step according to a file format. Lastly, the reassembly step determines fragmented parts and merges them into a file. This step increases restoration rate of the multimedia file by assigning a weight to each fragment using decoded frame difference. However, the method also uses a file-based approach and it has difficulty in restoring a video file when a part of video file was overwritten [14].

2.2 File carving

"File carving," or constantly simply being called "carving," is the process of extracting a collection of data from a larger dataset. Moreover, the data carving technique is frequently operated during a digital investigation when an unallocated file system space is analyzed to extract files. The files are carved from the unallocated space using file type-specific header and footer parameters. File system structures are not used during the process. The file carving is a powerful technique for recovering files and fragments of files when the directory entries are corrupted or missing. The data are searched block by block for residual data matching the file type-specific header and footer parameters. Through that carving is also especially useful in investigating criminal cases where it may be able to recover evidence. In certain cases related to child pornography, law enforcement agents are often able to recover additional images from a suspect's hard disk using carving techniques [15]. Moreover, forensic experts use file carving to squeeze every bit of information out of this media. As long as data is not overwritten or wiped, deleted data on all storage devices could be restored using carving techniques, including multifunctional devices and even mobile phones. Depending on the conditions, it is even possible to restore data from formatted disks. With the exhaustive measures of drives since 2006, there is huge chance that the data is not overwritten. For instance, let's say you have a two-terabyte drive, and you delete a document from that drive. The disk space reserved for that document will be marked "available," but it could actually take a long time before this address space on the disk is overwritten. There were forensic cases where discovered files stored on the disk years ago. File carving deals with raw data on the media and doesn't use the file system structure in its process. A file system, such as FAT16, FAT32, NTFS, EXT, is a structure for storing and organizing computer files and the data they contain. Though carving doesn't care about which file system is used to store the files, it could be ideal helpful to understand how a specific file system works. File carving techniques could be header-based, file structure and block-based carving, as well as the role of file validation in the file carving process [16].

2.3 MP4 Video file carving

Video sharing over the internet has become highly popular in the last few years. In the past, when the internet was not fully developed in terms of speed and bandwidth, the users were required to download an entire multimedia file and then save it to local disk before being able to view it [17]. Today, with the availability of very fast and affordable internet connections in most countries, multimedia contents can now be streamed over the internet without needing to download all of them first when viewing. In addition, a significant amount of video contents is being distributed over Peer-to-Peer (P2P) file sharing techniques [18]. With the advent of powerful mobile computing devices (e.g. smart phones and tablet PCs) and high-speed mobile data networks (e.g. 3G, 4G), together with social media services, the amount of video distribution over the internet has been growing exponentially. In accordance with this, the amount of shared illegal videos has also increased.

As in most countries, not only the distribution, but even the possession of certain image and video data are illegal, e.g. material containing child pornography, findings of such data during forensic investigations can be very important for evidence. Therefore, the capability of recovering and analyzing video data is crucial for them. During digital forensic investigations, investigators often encounter a situation where they are required to recover deleted data from a seized storage device. Traditional data recovery techniques are based on file system information. Such techniques use file system metadata information to recover deleted or corrupted files. In the case when metadata information is not available or the file system itself is damaged, these techniques cannot be used to recover the deleted files. That is the reason, we use advanced forensic techniques, such as file carving that works completely independent of the underlying file system [19]. With the file carving technique, the deleted contents could be recovered as long as they were not over- written.

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